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Hot Environment Assessment Tool (HEAT) User's Guide

by David Sauter

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14. ABSTRACT
Heat stress injuries in the military pose a significant problem in both training and tactical environments. The Hot Environment Assessment Tool (HEAT) was developed on a mobile computing device (an Android smart phone) to allow the determination of work/rest times and water intake requirements. This document provides a user's guide for HEAT.

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1. Introduction

The Hot Environment Assessment Tool (HEAT) application (referred to as the "app") provides guidance on work/rest and continuous work times, as well as water intake requirements as a function of weather conditions, Soldier work rate and clothing configuration. It also predicts and displays the Wet Bulb Globe Temperature (WBGT). Output is based directly on the guidance provided in the U.S. Air Force Technical Bulletin (Medical) (TBMD) 507 (Headquarters, Dept of the Army and Air Force, 2003).[1] The WBGT is computed from meteorological inputs, date/time and geographic location per formulations found in Liljegren (2008).[2] HEAT runs on Android-based smartphones (referred to as the "device").

HEAT was hosted on the device to address the issue of heat stress injuries in the military. A recent study (Carter et al., 2005)[3] indicated that, annually, there are over 200 injuries requiring hospitalization from heat stress resulting in an average of almost two deaths among U.S. Army Soldiers—hence, the rationale for developing such an app and making it available on a mobile device. Availability on a mobile device ensures that critical heat stress guidance is readily available at lower echelons where laptop or desktop computing platforms and/or network connections back to a higher echelon (from which heat stress warnings would likely be disseminated) are not available. For a more detailed discussion of mobile Android device relevance to the military see Sauter (2011).[4]

2. HEAT Inputs

To launch HEAT, simply tap the HEAT icon on the device (figure 1). The initial input screen is then displayed for the user to enter the site information (figure 2).

[1] Headquarters, Department of the Army and Air Force. *Heat Stress Control and Heat Casualty Management*. Technical Bulletin 507, Air Force Pamphlet 48-154(I); Headquarters, Department of the Army and Air Force: Washington, D.C., 2003.

[2] Liljegren, et.al. Modeling the Wet Bulb Globe Temperature Using Standard Meteorological Measurements*. J. Occup. Env. Hygiene* **2008**, 645−655.

[3] Carter, et al. Epidemiology of Hospitalizations and Deaths from Heat Illness in Soldiers. *Med. Sci. Sports. Exer*. **2005**, *37* (8), 1338–1344.

[4] Sauter, D. *Android Smartphone Relevance to Military Weather Applications*; ARL-TR-5793; U.S. Army Research Laboratory: White Sands Missile Range, NM, 2011.

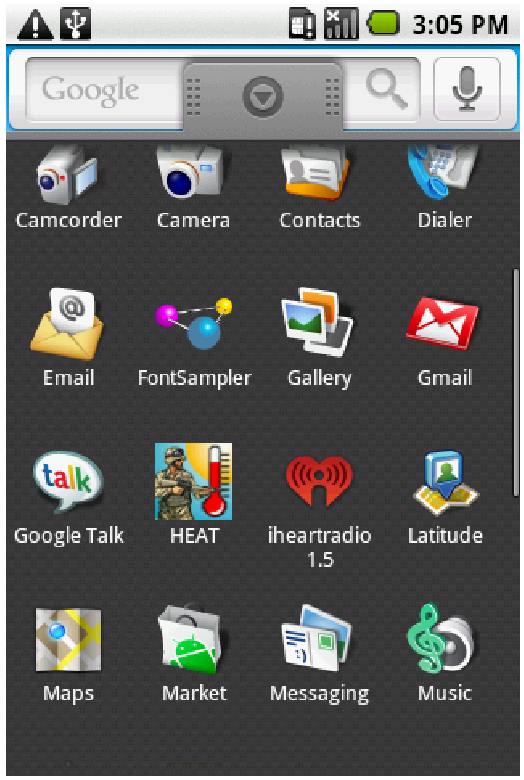

Figure 1. Launch HEAT.

Figure 2. SITE view.

HEAT is a multi-view (a view refers to an individual graphical user interface [GUI] screen) application with a tab bar (see upper portion of figure 2). The user enters the required inputs (default values always available) by tabbing through the various views and selecting the fields that the user wishes to modify. Numeric inputs are checked for appropriate values with a pop up message (see figure 3) displayed to the user in the event that a value is out of range or invalid (e.g., null). The invalid entry is also replaced with the last valid entry. Upon HEAT exit, valid input values are saved (via data persistence) for display the next time the app is started. Text field inputs (latitude and longitude fields), labels ("Latitude", etc), "Spinners" (a widget similar to a drop-down list used to select the latitude and longitude hemisphere fields), and DatePicker and TimePicker GUI elements are all used in the SITE view. A picker functions by the user tapping the "+" or "–" selectors above and below the displayed values to increment or decrement the values. The date/time defaults to the current device time as initially set up by the user. If a Global Positioning System (GPS) capability is present with the device, the latitude and longitude values could be automatically retrieved and displayed as the default values in the SITE view. Geographic location and date/time values are required to compute the solar insolation value.

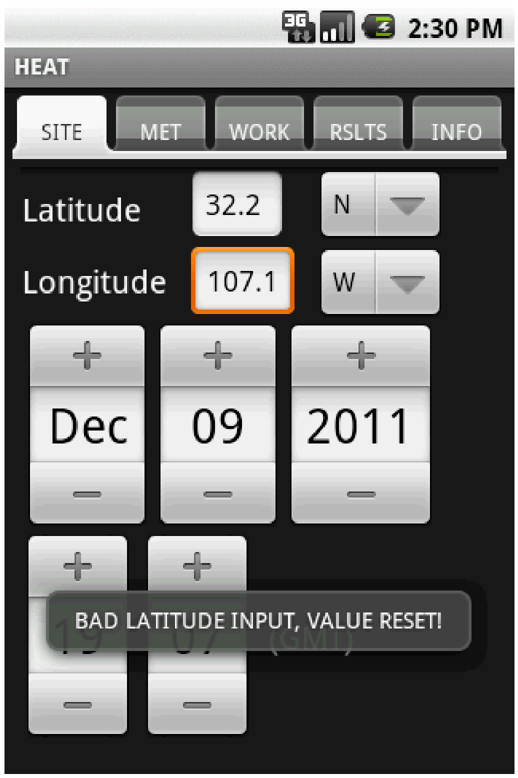

Figure 3. Bad latitude.

The next view in the sequence of tabs is the meteorological (MET) view (figure 4). This view allows the user to enter local weather conditions. As with the SITE view, this view consists of labels, text fields and a spinner (cloud type). A handheld weather sensor would typically be used in a tactical or training environment to assign the weather input values (wind speed, temperature and relative humidity) while a visual observation would provide the cloud input information. As the device utilized has a Bluetooth wireless capability, automated ingest of the weather data via remote connection to a handheld or other sensor (also equipped with Bluetooth) will be investigated in the near future. Accurate meteorological inputs are essential for computing the WBGT value. This value, in turn, is used in conjunction with the Soldier work rate and clothing configuration to determine the output values.

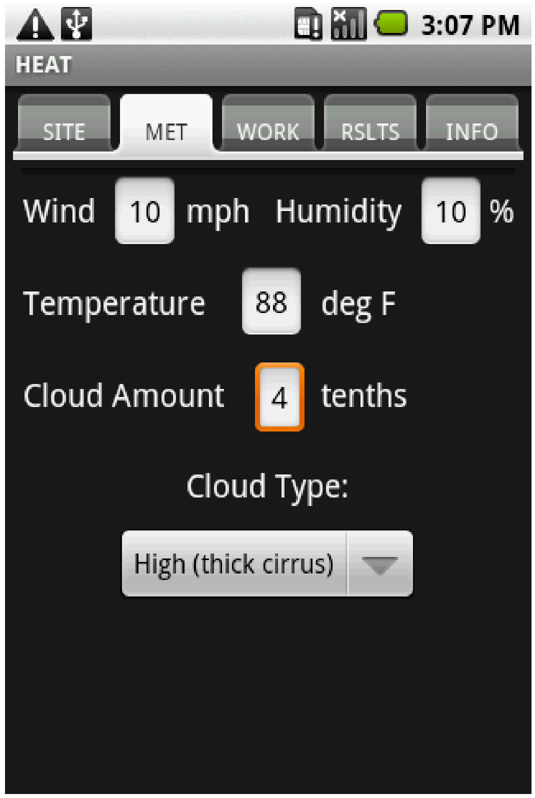

Figure 4. MET view.

Once the meteorological values are entered, the user will typically proceed to the WORK view (figure 5), used to input the details about the Soldier's work rate and clothing configuration. Obviously the higher the work rate, the shorter the work/rest cycle and continuous work time will be, all other inputs being the same. Note that "Spinner" widgets are used for both of the inputs. Descriptions of the various work rates are available in the bottom half of the screen.

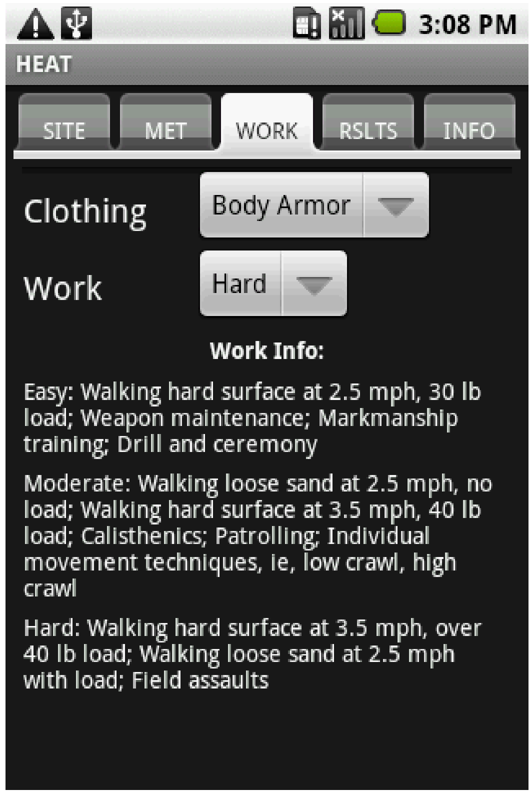

Figure 5. WORK view.

The next view for results, which is RSLTS view (figure 6), provides the user with the work/rest times (60-min cycle), the continuous work time (after which Soldiers must be given an extended recovery time, preferably in the shade), the water intake requirements for each of the times, and the WBGT. Immediately upon tapping the RSLTS tab, the app computes the WBGT value per the guidance in the Liljegren document mentioned previously. The computed WBGT value is then modified (if necessary) in accordance with the guidance provided in TBMED[5] as a function of the clothing level, work rate and humidity. For WBGT value modification purposes, “humid climates” as in the TBMED[6] are associated with a dewpoint temperature of 20 °C (assigned somewhat arbitrarily) or higher.

[5] Headquarters, Dept of the Army and Air Force, pg. 1.
[6] Ibid.

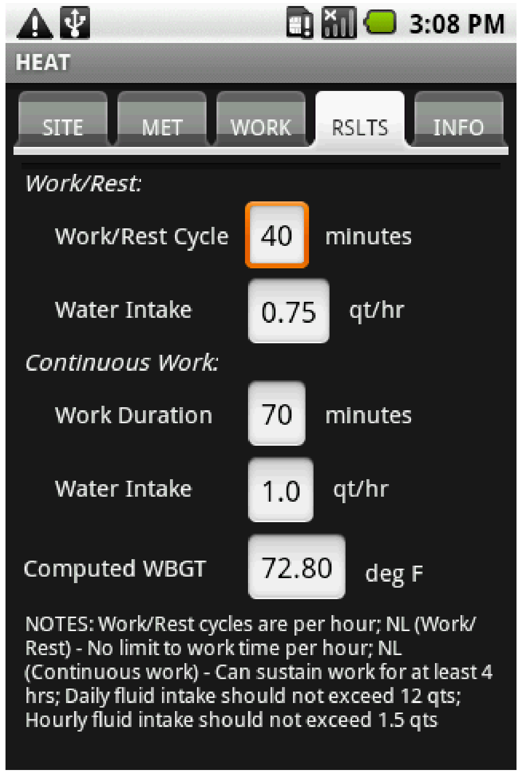

Figure 6. RSLTS view.

3. HEAT Output

Once the modified WBGT is determined, lookup tables in the TBMED[7] (hardcoded in the app) are used to determine the work/rest cycles (TBMED[8] table 3.1 not shown) and the continuous work times (TBMED[9] table 3.3 not shown). The results are computed in real time and displayed immediately upon tapping the RSLTS tab (figure 6).

Because there are initial default values assigned to all inputs upon startup of the app, it is not necessary to proceed through all or any of the input views. It is easy to do "what-if" scenarios with the app by modifying one or more inputs (e.g., work rate) to see what the impact of this/these change(s) is/are.

The last tab (figure 7) available simply provides information regarding the app developer, version, and point of contact.

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7 Ibid.
8 Ibid.
9 Ibid.

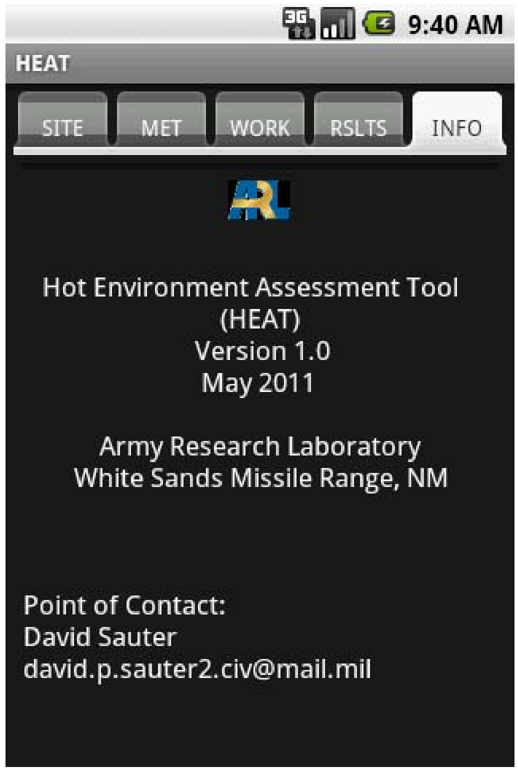

Figure 7. INFO view.

4. Conclusions

HEAT provides an easy-to-use and readily understood capability to determine work/rest cycles, continuous work times, and water intake values based on local weather conditions. Hosting on a mobile device should make it accessible virtually anywhere in a tactical or training environment.

A WBGT validation effort using archived meteorological measurements (to include the WBGT), site, and time data is anticipated in 2012. Assuming satisfactory results from this evaluation, the app will be uploaded to the Army Marketplace website for personnel who have a Common Access Card (CAC) to download and use.

List of Symbols, Abbreviations, and Acronyms

CAC	Common Access Card
GPS	Global Positioning System
GUI	Graphical User Interface
HEAT	Hot Environment Assessment Tool
MET	meterological
RSLTS	results
TBMED	Technical Bulletin (Medical)
WBGT	Web Bulb Globe Temperature

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